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Gabriel A. Facchini Palma

Universitat Autònoma de Barcelona

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Departament d´Economia Aplicada

Edifici B

Campus de Bellaterra

08193 Bellaterra

Telèfon: 00 34 935 811 680

E.mail: d.econ.aplicada@uab.cat

https://www.uab.cat/departament/economia-aplicada/

Low Staffing in the Maternity Ward: Keep Calm and Call the Surgeon

Gabriel Facchini*

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Abstract

This paper examines how workload affects the provision of care in a large but under-studied segment of the healthcare sector – maternity wards. I use detailed patient-level administrative data on childbirth, and exploit quasi-random assignment of unscheduled patients to different staffing ratios. I find that patients who at admission observe a higher ratio of patients-to-midwives are more likely to receive a C-section. I show that this result is not attributable to patients' differential sorting across workload levels. Instead, I find evidence that C-sections are used to alleviate midwives' workload -they are faster than vaginal births and performed by physicians. I also exploit patient's civil status to determine whether the effect varies with patient's bargaining power -single women are on average more likely to be alone in the delivery room. Consistent with induced demand, only single patients are more likely to receive a C-section when admitted at high workload levels.

JEL Classification: D82, H42, H51, I18, J13, J16, J22

Keywords: cesarean section, workload, midwives, physician induced demand, bargaining power

*Department of Applied Economics, Universitat Autònoma de Barcelona, Spain. Email: gabriel.facchini@uab.cat. I would like to extend my gratitude to Andrea Ichino and Jérôme Adda for their invaluable support and advice throughout this research project. Thanks also to Juan Dolado, Matilde Machado, Joseph Doyle, Libertad González, Daniela Iorio and Matthew Neidell for their help and feedback on this project. I am extremely grateful to Carlo Dani, Simone Pratesi, Federico Mecacci, Lucia Pasquini, Franca Rusconi and Luigi Gagliardi for their clinical expertise, and to Tommaso Lanis and Francesca Superbi for their assistance in accessing the data. All errors remain my own.

1 Introduction

Over the last decades health care systems in developed countries have been under constant pressure to reduce costs, despite facing an increasing demand for health care services. In order to avoid a trade-off between cutting down on costs and a negative impact on patient's health outcomes, experts currently point towards the reduction of waste as the best way to go (Berwick and Hackbarth, 2012). Among the several sources of waste, two widely cited ones are: (i) failures of care delivery -the lack of adoption of known best practices-, and (ii) overtreatment -the carrying out of treatments that cannot possibly improve patients' health. These two sources of waste are particularly salient in maternity ward settings.

The presence of midwives -as opposed to physicians- in assisting birth speaks to the first point. Even though there is consensus about the crucial role of midwives in guaranteeing access to quality services and better health outcomes for both mother and child (Bender et al., 2014), the WHO has already expressed concern about a worldwide "shortage of midwives" (Büscher et al., 2009).[1]

Meanwhile, cesarean sections (C-sections) are the most commonly performed operating room procedures in the US (McDermott et al., 2017) and rank highly among greatly overused interventions. While the international healthcare community considers an ideal rate of C-sections to be between 10-15% (World Health Organization, 1985), country average rates in Europe vary from as low as 15.6% in The Netherlands to as high as 36.8% in Italy (OECD data 2012). This large variation in C-section rates has lead governments and clinicians to express their concern about its possible overuse and potential negative impact on patients health (World Health Organization, 2015). Indeed, C-sections not only cost more than vaginal deliveries, but they also imply higher risks for both the mother and the infant (Deneux-Tharaux et al., 2006; Gregory et al., 2012; Curtin et al., 2015; Costa-Ramón et al., 2018) and, according to a growing medical literature, are associated to lower long-term outcomes of children's health.[2] In addition, because vaginal delivery after a C-section (VBAC) is very

[1] This has also been mentioned by midwifery colleges. In a 2015 report, The Royal College of Midwives estimates that the UK "...needs 2,600 more midwives to be able to cope with the number of births the country is experiencing...". The Federal Association of Midwives of Spain (FAME) has as main objective to address the shortage of midwives in the health care system. The president of the Italian Midwifery Association recently stated that "...there is a shortage of midwives. Too few to guaranty the proper level of care that other European Countries have".

[2] Infants born by C-section are not exposed to the maternal bacteria of the birth canal and as a consequence have different intestinal bacteria, which can affect their immune system and other important processes. For a meta-analysis of this literature see (Blustein and Liu, 2015). There is also an emerging economic literature looking at the causal link between C-sections and children's health. They find that babies born by C-section are more likely to visit the ED for a respiratory-related problem within their first year of life (Card et al., 2018, 2019) and more likely to be hospitalized for asthma syndromes up to their adolescence (Jachetta, 2015) with respect to babies born vaginally.

unlikely, one C-section sets a path dependency for more C-sections in future births.[3] There is also evidence that women who follow a C-section are more likely to have less children (Norberg and Pantano, 2016) -something that is particularly alarming in developed countries with already low fertility rates- and to develop postnatal depression (Tonei, 2019).

In light of these concerns, a natural question is whether a situation of low midwifery staffing can result in more unnecessary C-sections being performed. There are two ways in which high midwives' workload can lead to a raise in C-sections. First, patients' health may worse with lack of midwives care to a point where a C-section is clinically recommended. Second, physicians may decide to change to surgery to reduce midwives' workload. C-sections take less time than vaginal births since there is no need to wait for the appropriate dilation of the cervix. Furthermore, C-sections are less intensive in midwives' time and more intensive in physicians' time.[4]

To identify the causal effect of workload on the probability of getting a C-section, I exploit a simple natural experiment that varies the level of workload each patient is exposed to in an arguably random manner. This is the case for all unscheduled patients, those that follow the natural course of birth and only go to the hospital once labor has already started and/or their water has broken. Because their precise day and time of admission to the hospital is unknown, the unit's workload level upon being admitted is orthogonal to the patient's demographic and health characteristics (and to their ex-ante probability of delivering by C-section). In addition, my measure of workload varies with both the number of patients who arrived before and the number of midwives on duty in the delivery room, two variables that are unknown to the incoming patient. I provide evidence that the time of admission is uniformly distributed across hours of the day and days of the week only for these unscheduled patients. Moreover, I show that workload is not correlated with commonly known predictors of C-sections like birth-weight, gender, being a first-time mother, age, and ER visits during pregnancy.[5]

The data for this paper comes from a census of births from a large academic medical center in Italy for the period 2011-2014. Three features of this data set make it well suited for tackling the issue at hand. First, Italian birth certificates have precise information on delivery method, allowing the identification of patients attempting a vaginal delivery and those who have a scheduled C-section.[6] This information is crucial to exclude scheduled

[3]VBAC rate is only 8.3% in the US, and 12% in Italy.

[4]Although recovery time is longer after a C-section relative to a vaginal birth, post-birth care is administered by another staff-team outside the delivery room in the post-natal unit.

[5]The random arrival of unscheduled maternity ward patients is also used by Johnson et al. (2016) for estimating the causal effect of delivering with an OB with whom they have a pre-existing clinical relationship.

[6]Even though this may seem as very straight forward information, vital statistics in the US didn't report any information on 'trial of labor' until 2004, making it impossible to separate scheduled from unscheduled

patients from the analysis sample since their time of admission to the hospital has been arranged in advance with the physician. Second, using patient's ID, each certificate was linked with time stamps containing the exact time of admission and discharge. I use this information to compute the actual number of patients waiting in the delivery room at each point in time. Finally, this is complemented with data on the number of midwives scheduled for duty by month, day of the week and shift. This allows me to adjust demand by supply-side factors. My measure of workload is then calculated as the ratio between the observed number of unscheduled patients waiting to give birth at the time the indexed patient is admitted and the number of midwives scheduled to be in the delivery room.

The analysis is divided in two parts. First, I show that there is a non-linear relationship between midwives' workload and delivery method: patients admitted when the ratio of patients-to-midwives is above the 20th percentile (High RPM) are two percentage points more likely to give birth by C-section. This means that about 15 percent of unscheduled C-sections are a consequence of low midwifery staffing. I also find that other measures of treatment intensity are not affected by workload. Finally, controlling for method of delivery, maternal and infant morbidity are similar for low and high workload levels.

The second part of the analysis looks at whether physician induced demand (PID) plays a role in this difference of treatment between patients admitted during high and low staffing. Within the agency discrimination framework, physicians are more likely to practice an unnecessary surgery on patients with lower bargaining power. I tests for the presence of agency using patient's civil status, that is, comparing single and married patients. Single patients are -on average- more likely to be alone in the delivery room, reducing the physician's cost of inducing a C-section. Indeed, the probability of delivering by C-section between these two groups is virtually the same for low-workload levels. However, single patients observe a rise in the probability of C-section with a rise in workload.

2 Related literature

This paper contributes to a large literature looking at the effects of workload (measured as patient-to-staff ratios) on patient health outcomes. Most prior studies use exogenous variation in workload stemming from new legislation raising the mandatory minimum staffing ratios (Tong, 2011; Cook et al., 2012; Lin, 2014; Matsudaira, 2014; Chen and Grabowski, 2015). One exception is Evans and Kim (2006), who use variation in the number of admissions in the two days after as an exogenous shock to the effective staff level. These papers find mixed results in terms of the effect of workload on quality of care. My contribution to this

patients before that date.

literature is twofold. First, previous studies using legislative changes exploit an aggregate, permanent and positive variation in capacity (Harris et al., 2019), while I use *temporary* and *stochastic* changes in the staffing ratios that vary at the *patient* level. Second, to the best of my knowledge, I provide the first causal estimates of the effect of workload on health outcomes in the maternity ward setting.

In contrast, there is little empirical work on the effects of workload on the provision of health care (i.e. the channel through which workload may affect health outcomes). There are, however, several recent and concurrent papers tackling this issue using health-care provider administrative data. Harris et al. (2019) look at exogenous changes in nurse capacity in five public clinics in Tennessee and find that providers value sufficient time spent with patients over seeing more patients. Alkalay et al. (2018) use data from eleven primary care clinics in Israel and exploit the absence of colleagues as a source of exogenous variation in physician workload, and find that referrals to specialists and lab tests go down with shorter visits. Neprash (2016) finds that primary care physicians perform fewer procedures and record fewer diagnoses for appointments that start later due to physicians being behind schedule. Finally, Freedman et al. (2018) use unexpected schedule changes as variation in primary care physician's time pressure and find that higher pressure reduces the number of diagnoses recorded and increases both scheduled and unscheduled follow-up care. My paper differs from these papers in three important ways. First, all these papers focus on primary care, an environment where time pressure is among the lowest in health care. Meanwhile, a maternity-ward's demand is mainly driven by unscheduled patients that need assistance within a relatively short span of time.[7] Second, with the exception of Freedman et al. (2018), these papers use shocks to provider availability and time (supply side) while I exploit stochastic variation in patients arrivals driven by nature (demand side). Finally, with the exception of Alkalay et al. (2018), all these papers use data from the US, a context where financial incentives have been shown to significantly affect health-care provision (Clemens and Gottlieb, 2014; Ho and Pakes, 2014).[8] On the contrary, physicians in Italy receive a fix salary, and non-financial incentives may play a bigger role in the supply-driven variation in treatment.[9]

[7] In a recent working paper, de Elejalde and Giolito (2019) use a policy change in co-payment in Chile that incentivizes patients to move to private hospitals and observe that this increase in the number of patients at private hospitals is linked to a rise in the probability of having a C-section. Their work differs crucially from mine in that they use an 'expected' measure of workload at the 'hospital' level, and show that hospitals increase the number of scheduled C-sections in anticipation of a positive demand shock.

[8] Although this is not exclusive to the US. Brekke et al. (2017) find that physicians in Norway respond to fee changes.

[9] Recent work suggest that non-financial incentives may also be important for the US market. Using survey data linked to fee-for-service Medicare expenditures, Cutler et al. (2013) find that "physicians' responsiveness to financial factors play a relatively small role in explaining equilibrium variations in utilization patterns in

A large related literature studies how physicians may induce a patient's demand against the physician's interpretation of the best interests of the patient (Johnson, 2014). Many of these papers have focused on the maternity ward set-up and the decision of delivery method due to its discretionary nature. One strand of this literature assumes the presence of information asymmetry and exploits variation in a wide range of physicians' incentives to induce. Starting from Gruber and Owings (1996) where they use a fall in physician's salary as a trigger for more C-sections, to other incentives like relative prices between C-sections and vaginal deliveries (Gruber et al., 1999; Alexander et al., 2013; Allin et al., 2015), defensive medicine (Currie and MacLeod, 2008; Dranove and Watanabe, 2009; Bertoli and Grembi, 2019), and physician's scheduling convenience (Lefèvre, 2014).[10] Unlike previous studies, my findings suggest that physicians may have incentives to perform medically unnecessary C-sections for reasons other than personal gain.[11] Indeed, if physicians cannot adjust the price nor the quantity, they may resort to lowering the quality of treatment. In the maternity ward setting, a patient's unnecessary C-section can alleviate midwives' workload and allow them to better attend other patients.

Another strand of the literature on PID uses heterogeneity in information asymmetry to explain the variation in C-section levels. Two recent papers compare the treatment received by expert and non-expert patients in the maternity ward set up. Grytten et al. (2011) observe that, in an institutional context with incentives to reduce C-sections, non-expert patients get less C-sections than expert patients. They conclude that a model of statistical discrimination (expert patients are better at communicating with the physician) explains their results better than one of agency discrimination (the physician influences the diagnosis and treatment for non-expert patients). On the contrary, Johnson and Rehavi (2016) find evidence that physicians are more likely to exploit the information asymmetry when it is profitable (agency discrimination). They do so by comparing physician patients with non-physician patients, in settings with and without financial incentives to perform C-sections. My paper differs from them in that I refrain from exploiting variation in information asymmetry. Instead, I use variation in the presence of another person in the delivery room caring for the patient's interest (husband) and raising the physician's cost of inducing an unnecessary treatment.

our context".

[10]For an extensive review of the literature on PID in the maternity ward setting see Allin et al. (2015).

[11]One exception is Johnson et al. (2016), where the authors find that physicians are 25% more likely to perform a C-section on patients with whom they have a pre-existing clinical relationship and argue this is due to physician's greater disutility from own-patients' difficult labors.

3 Clinical and Institutional Setting

3.1 Choice of delivery method

Maternity wards receive two types of patients: scheduled and unscheduled. The former includes patients admitted for an elective C-section and those who will be induced.[12] For patients following an elective C-sections the date of delivery is set in advance, and there is no possibility for changing delivery method (unless the mother goes into labor before). These pregnancies typically present some health condition that constitute a risk for the mother and/or the baby if delivered vaginally. Similarly, induced patients already know in advance the date they will be induced but, although they will attempt a vaginal delivery, the physician may still decide to change delivery method on the way if considered necessary.

The remaining patients, those attempting to follow the natural course of labor and vaginal delivery, are the main focus of this study. For these patients the process starts with frequent contractions and/or because they believe their water has broken (spontaneous onset of labor). Once the mother arrives to the hospital she is evaluated and if in active labor, she is admitted into the labor and delivery room and assigned a gynecologist and a midwife. If everything goes as planned and the patient is able to have a vaginal delivery, the midwife will be the one helping her through out the whole process.[13] Nevertheless, during labor there are several medical conditions that can emerge and complicate a vaginal birth, putting in danger the health of the infant and/or the mother. Under these circumstances, the midwife and gynecologist may decide to recommend to have a C-section instead. More importantly, the presence of some of these medical conditions depends heavily on the subjective opinion of the physician.[14] This gray area -or asymmetry of information- on when a C-section is necessary gives the medical team more room to recommend surgery to the patient, even when not medically needed.

3.2 Mechanisms

There are, at least, two ways in which high midwives' workload can lead to a raise in C-sections. One possibility is that, during high workload, the midwives' time dedicated to each patient is lower and the quality of care inappropriate, eventually resulting in the need for C-section. Under this scenario, shifting delivery method can be optimal for the patient.

[12] Most inducements are performed on pregnancies that have past their due date and still haven't started labor.

[13] This is in stark contrast to the standard Obstetrician-led maternity care in the United States where physicians are in charge of all births, including uncomplicated vaginal deliveries.

[14] Two of these more 'subjective' conditions are dystocia (abnormally slow labor) and fetal distress

Alternatively, a raise in C-sections with workload can be a consequence of physician induced demand (PID). When the demand for midwives increases (more unscheduled births), holding everything else constant, the team may find it optimal to shift patients from midwives to physicians by changing delivery method. Since a C-section takes less time than a vaginal birth -no need to wait for the appropriate dilation of the cervix-, midwives' workload would be reduced. Unlike in the previous case, under PID the patient receiving an unnecessary C-section is not getting optimal treatment.

3.3 Childbirth in Italian public hospitals

The maternity unit analyzed in this paper is part of one large teaching hospital in Italy. The staff working in the delivery room are paid a fixed salary, meaning they have no personal financial incentive to recommend any particular treatment. On the other hand, hospitals are reimbursed depending on a DRG (Diagnosed-related group) tariff system, which in general gives a higher reward for a C-section than for a vaginal delivery.[15]

Figure B.1 uses hospital-level data for Italy in 2017 to show that the rate of C-section is negatively (positively) correlated with the percent of births assisted by a midwife (gynecologist). Table B.1 shows estimates of a linear regression are statistically significant. Although no causal interpretation can be drawn, this provides evidence of variation in both C-section rates and the use of different health-worker types between Italian hospitals.

4 Empirical Methodology

4.1 A natural experiment

An ideal experiment to test for an effect of workload on patients' delivery method would imply assigning parturient women randomly between two different hospital types: a first one with already a large number of patients and a second type, identical to the first, but with few patients and hence ready to focus entirely on the coming patient. This is not possible to implement in practice for obvious reasons.

This paper focuses on patients who attempt to have a vaginal delivery, and uses plausibly exogenous variability in the number of patients and midwives present at admission to causally identify the impact of workload on delivery method. For the majority of births, the time of arrival is unknown to the hospital beforehand. In the same way, the capacity utilization of the maternity ward in a given point in time is unknown to the patients until they reach

[15]For a deeper discussion on the Italian Health System see Francese et al. (2014).

the hospital. For these patients, their pre-admission probability of developing a complication and delivering by C-section is orthogonal to the level of crowding at the hospital.

The study sample includes all births that, up to the point of arriving to the hospital, followed the "natural" course of pregnancy and labor. This means leaving out all scheduled deliveries where the physician decided, together with the patient, the date when the birth should take place. This type of patients are those who had an elective C-section or who were pharmaceutically induced to start labor.[16]

The left column of Figure 4.1 shows the distribution of admissions by hour of the day and day of the week. The right column does the same for births. Both scheduled and unscheduled patients distributions are plotted separately for comparison. Admissions of scheduled patients are concentrated in the afternoon, while births start at 9 a.m. and become less and less frequent as the day goes by. Instead, both admissions and births for unscheduled patients are very close to a uniform distribution within a day, albeit with a slightly higher frequency around midnight and a lower frequency in the evening. This is in accordance with previous studies in the medical literature which find evidence of a significant circadian frequency in both the onset of labor and birth of "natural" deliveries, with a peak frequency around midnight and a lowest point in the afternoon (Charles, 1953; Kaiser and Halberg, 1962; Glattre and Bjerkedal, 1983). Although these differences in observations across the time of the day are small, I will include fixed effects for shifts (or hour) of admission to address potential selection effects.

Similarly, when looking at the distribution by days of the week, unscheduled patients are randomly distributed while scheduled patients are less common to be admitted on Saturdays, and less likely to have surgery on Sundays and Saturdays. In Appendix A, I repeat the exercise disaggregating scheduled patients in scheduled C-sections and induced deliveries. Results are qualitatively the same, with both categories showing non-uniform distributions across days and hours.

4.2 Data

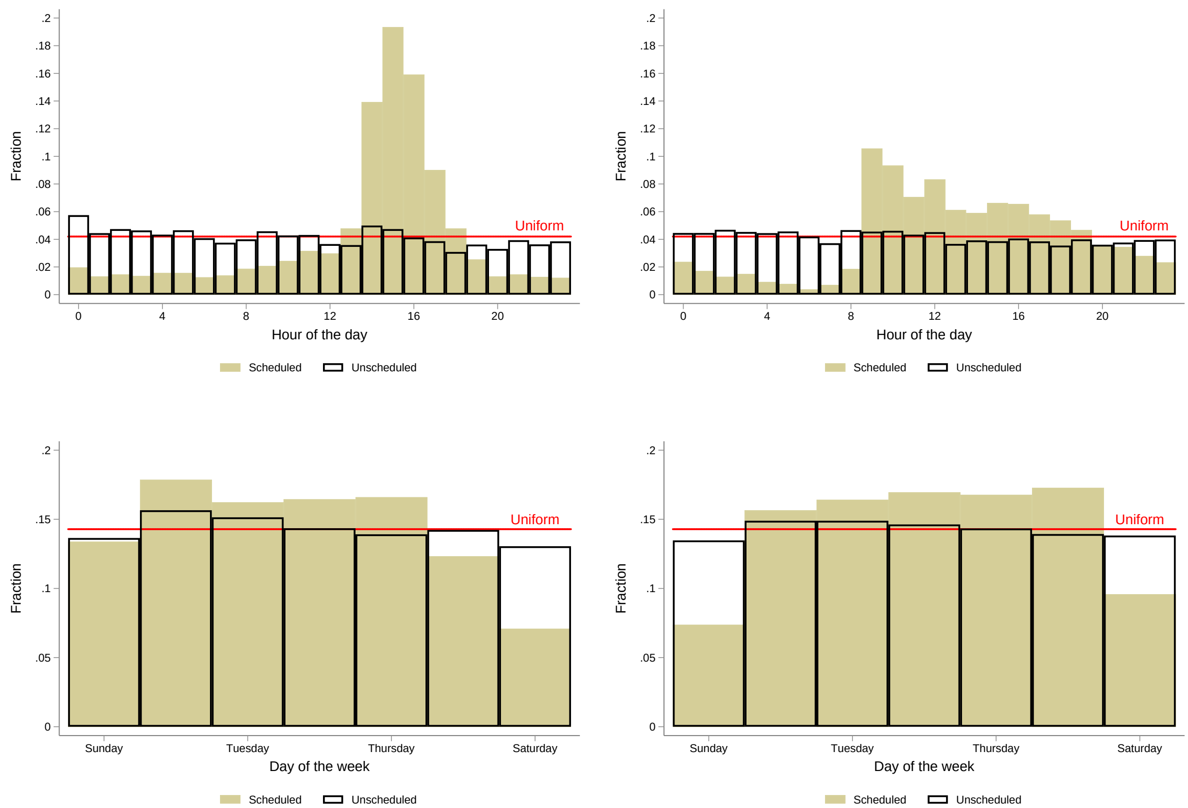
Previous studies looking at newborns' health typically use anonymous birth certificates which are publicly available for many countries and for long periods of time. However, these data sets commonly lack information on key variables needed for a rigorous study of staffing levels, namely, the exact date and time of admission of patients (demand side) and the number of staff available (supply side) in each delivery unit.

The clinical setting for this study is the maternity ward of a large public university hos-

[16]For more evidence supporting the criteria for selecting the working sample see Appendix A.

Figure 4.1: Distribution of admissions and births.

(a) Admission (b) Birth



Notes: Scheduled patients include elective C-sections and patients who were induced into labor. Unscheduled patients are those who started labor and attempt a vaginal delivery.

pital in Tuscany (Italy) during the years 2011-2014. With a 31% average C-section rate, this hospital is very close to the national Italian rate of 33% among public hospitals in 2012.[17] The primary databases used are two: (i) birth certificates (Certificato di assistenza al parto); and (ii) hospital admissions (Scheda di Dimissione Ospedaliera). Birth certificates constitute a census of all births that took place in the hospital in this period. They contain information on mother characteristics (e.g. community of residence, education, civil status, age, previous deliveries, etc.), pregnancy characteristics (e.g. weeks of gestation, controls, assisted reproduction, etc.) and birth characteristics (e.g. time of birth, type of labor, attendant, place, weight of the baby etc.). The administrative hospital admission data provides information on the time of admission and time of discharge for each patient. Using unique mother-pregnancy identifiers, both databases can be linked.

[17] Hospital and national statistics were obtained from ARS Toscana (2014) and Ministero della Salut (2012) respectively.

The aforementioned data on patients is complemented with information on the level of staff scheduled to be present in the delivery room each month, day of the week and shift combination. Note that this is not the effective level of staff present at each point in time but the staffing rule of the delivery unit. Anecdotal evidence suggests that deviations from planned levels are rare, even because the hospital calls in someone else when an employee misses a shift.

There were approximately 11,359 singleton births at this hospital between 2011 and 2014. After excluding all scheduled patients the sample goes down to 6,479 births. Finally, after dropping observations with missing time of admission, maternal age, education, birth order, weight and prenatal visits, and patients arriving the first and last 15 days in the sample, the number of observations in the working sample is 6,142. The models described below are fitted to this sample. Table 4.1 summarizes the variables used in the analysis.

4.3 An exogenous measure of midwives' workload

A good measure of workload contains information on both the number of patients and hospital's staff. For the maternity ward setting I use the ratio of patients to midwives (RPM) in the delivery room.[18] The richness of the data in hand allows me to construct a very precise measure of the number of parturient women in the maternity ward at any point in time and to differentiate between those waiting to give birth and those in postpartum.

There are yet two decisions to be taken regarding the moment at which this ratio is calculated and the type of patients to include in the numerator. On the former, because the median patient stays 7 hours in the delivery room between admission and birth, it is not obvious at what time to measure the level of staffing. The two most straightforward options are at the time of admission and at the time of birth. The last one has the advantage of measuring staff when needed the most, meaning, when the mother needs help to give birth. The problem with this option is that, given that physicians can rush a delivery (e.g. by doing a C-section), the level of staffing at time of birth can be endogenously determined. On the other hand, even though the level of staffing at time of admission can be relatively less relevant, it is indeed an exogenous shock. For these reasons I will use the ratio of patients to midwives calculated at the time of admission of each patient.[19]

On the second issue, it is important to decide which patients are included in this measure

[18] One drawback of this measure is that it constraints the coefficient of interest due to the simultaneous variations in numerator and denominator. The fact that my preferred model specification uses fixed effects by shift and day-of-the-week means that all the variation used for the estimation comes solely from fluctuations in the numerator, alleviating this issue.

[19] In the following section I perform several robustness check measuring staff levels at different points in time during a patients stay and discuss the results.

Table 4.1: Balance table of patients admitted at low and high RPM

	Low RPM		High RPM		
	Mean	SD	Mean	SD	Diff.
Mother characteristics					
(mean) age	32.4	5.6	32.6	5.6	-0.16
% middle school	76.8	42.2	77.4	41.8	-0.61
% married	64.8	47.8	63.3	48.2	1.43
% first-time mothers	41.1	49.2	42.3	49.4	-1.22
Pregnancy characteristics					
% preterm (<37 wofg)	6.9	25.3	5.8	23.4	1.04
% with at-least 1 ER visit	13.0	33.6	12.5	33.1	0.42
Infant characteristics					
% male	53.3	49.9	51.2	50.0	2.09
(mean) weight in grams	3,243.7	575.2	3,271.4	521.9	-27.67
% low birthweight (< 2,500gr)	5.9	23.6	4.8	21.4	1.11
% high birthweight (> 4,000gr)	5.1	22.0	5.0	21.8	0.07
Outcomes					
% vaginal births	91.1	28.4	89.2	31.0	1.91*
% unscheduled C-sections	8.9	28.4	10.8	31.0	-1.91*
% operative births	9.3	29.1	8.7	28.1	0.66
% post-partum hemorraghe	9.8	29.7	11.7	32.2	-1.95*
(mean) length of stay in hours	77.0	30.8	73.6	29.9	3.39***
% transfered to neonatal ICU	8.4	27.8	6.9	25.4	1.50
% lack of skin-to-skin contact	18.1	38.5	17.9	38.4	0.21
% non-exclusive breastfeeding	33.0	47.1	32.0	46.7	1.01
% Apgar score<9	5.2	22.1	4.6	21.0	0.56
Observations	1297		4845		6142

Notes: Table contains variables used in the empirical analysis for the main estimation sample for the period 2011-2014. Notably, the sample is limited to singleton mothers who went into labor before giving birth (i.e. attempt a vaginal delivery) without inducement. The last column reports differences in means between patients admitted during high and low RPM and whether they are statistically significantly different from zero and standard levels.

of demand. The first option would be to include all patients (regardless of whether they are scheduled or induced). Nevertheless, since the main outcome of interest is the probability of C-section, counting elective C-sections in the measure of staffing would make it biased. To see this, note that when there are more elective C-sections there are also more gynecologists ready to perform them. Incorporating elective C-sections in the numerator would not only include a demand side but also a change in the supply of physicians who can perform C-sections. For this reason, I include in the numerator all patients but those already scheduled to give birth by C-section.[20] Also note that these are the type of patients that shift the demand of midwives' service but not that of physicians' services -who take care of complicated deliveries that use instruments or surgery.

Then, the workload observed by a patient admitted at time t is defined as

$$\mathrm{RPM}_t = \frac{\mathrm{Patients}_t}{\mathrm{Midwives}_t} \tag{1}$$

where the numerator is the number of patients waiting to attempt a vaginal birth, and the denominator is the number of midwives scheduled to be present in the delivery room. The lower panel of Figure 5.1 shows the distribution of the RPM. The ratio is unimodal and slightly skewed to the right. On average, there are 2.3 patients for every midwife in the delivery room. Table 4.2 shows the mean number of midwives and patients in the delivery room by day of the week and shift of admission -and their ratio.[21] The number of midwives is higher during the morning shift (5), and lower at nights and Sundays (3). On the other hand, the average number of patients is virtually the same across days of the week and shifts, with a slightly lower level on Sundays.[22]

4.4 Econometric specification

The first part of the analysis estimates OLS regressions of a binary indicator for C-section on the treatment variable along with demographic and clinical controls. A simple reduced-form linear probability model of the following type is used:[23]

$$\mathrm{y}_{it} = \alpha + \beta\, g(\mathrm{RPM}_t) + \theta\, \mathrm{X}_i + \theta_t + \epsilon_{it} \tag{2}$$

[20] Note that this is not the same sample as the study sample because it also includes induced deliveries. Those are not at risk of contaminating the measure because they will still attempt a vaginal delivery, and need a midwife to help them.

[21] The scheduled number of midwives is constant across months and years in the sample.

[22] The difference with Sundays is due to the fact that there are less induced births.

[23] A probit model was also estimated assuming a normal distribution of the error term and results are virtually the same (See Table B.2).

Table 4.2: Descriptive statistics for the RPM

	Midwives		Patients		RPM	
	Mean	SD	Mean	SD	Mean	SD
Weekdays						
Morning (7am-1pm)	5	0	8	2.6	1.6	.53
Afternoon (1pm-7pm)	4	0	8.4	2.9	2.1	.72
Night (7pm-7am)	3	0	8.1	2.7	2.7	.89
Saturdays						
Morning (7am-1pm)	4	0	8.2	2.6	2.1	.64
Afternoon (1pm-7pm)	4	0	8.2	2.4	2	.61
Night (7pm-7am)	3	0	7.9	2.6	2.6	.87
Sundays and holidays						
Morning (7am-1pm)	3	0	7.8	2.7	2.6	.91
Afternoon (1pm-7pm)	3	0	7.8	2.8	2.6	.92
Night (7pm-7am)	3	0	7.6	2.6	2.5	.87

Notes: Based on the maternity's scheduled of midwives and birth certificates from the main sample for the period 2011-2014.

where y_i is a dummy variable indicating whether birth i had an unscheduled C-section, and RPM_t is the ratio of patients-to-midwives observed at admission time t -constructed as described in Section 4.3. X_i contains individual-level control variables of mother and pregnancy characteristics.[24] To control for seasonal and secular variation in outcomes, I include additive fixed effects for shift, day of the week, month, and year of admission (θ_t). Since most supply side changes in the maternity ward take place between shifts and days of the week, I perform robustness checks using fixed effects for day-of-the-week times shift, and using hour of admission fixed effects. Results are virtually the same. β is the coefficient of interest. As discussed above, if patients are more likely to receive a C-section when the RPM is high, then we expect β to be positive.

The second part of the analysis looks at whether physician induced demand (PID) is a possible mechanism through which workload affects the choice of delivery method. When resources are constrained, e.g. high RPM, physicians may see optimal to shift some patients to the operative theater to give birth by C-section. This would reduce midwives' workload by reducing the number of patients waiting in the delivery room. Because patients are heterogenous, physicians will find it easier to offer this treatment to some patients than others. I use patient's civil status as a proxy for bargaining power. For a single woman in

[24] These include: a dummy for whether the mother is above 34 years old, a dummy for whether the mother has finished middle school, a dummy for whether this is her first pregnancy, a dummy for whether the infant is a male, a dummy for whether is a pre-term birth (below 37 weeks of gestation), a dummy for whether the baby is born with low weight (less than 2,500 grams), and a dummy for whether the mother had at least one emergency check up during pregnancy.

Tuscany, the odds of being alone in the delivery room are 1.25 times larger than the odds for a married woman (ARS Toscana, 2013).[25] In those cases, the physician only needs to convince one person about the change in procedure -not to mention the patient is in labor and in a lot of pain, which makes it harder to analyze the pros and cons of each alternative. A large medical literature finds that continuous companionship during labor improves women birth experience in several dimensions, including, a reduction in the probability of having a C-section (Bohren et al., 2017).[26]

To test whether the effect of workload varies by civil status, I estimate the following regression:

$$\mathrm{y}_{it} = \alpha + \beta_1 \,\mathrm{RPM}_t + \beta_2 \,\mathrm{RPM}_t \times \mathrm{Married}_i + \beta_3 \,\mathrm{Married}_i + \theta \,\mathrm{X}_i + \theta_t + \epsilon_{it} \tag{3}$$

where $\mathrm{Married}_i$ is an indicator for whether the patient is married or not. The remaining variables are defined as in equation (2), adding civil status as a control. I expect married patients to be less affected by a high RPM, hence, a negative β_2.

5 Results

5.1 Provider response to workload

The top panel in Figure 5.1 provides the most direct illustration the effect of workload on the probability of having a C-section, and depicts the essence of the research designed used in the paper. It shows predicted values from two models that allow for non-linear effects between workload and C-sections. First, the solid line corresponds to a model where the independent variables are dummies for quintiles of the RPM (leaving out the first quintile as the base category).[27] This allows the effect to vary along the distribution of workload. We can observe a jump in the probability of C-section after the first quintile, and then a relatively stable probability of C-section for higher levels of workload. This is borne out by the dashed line in the Figure, which shows a similar break using a nonparametric (local linear) regression.

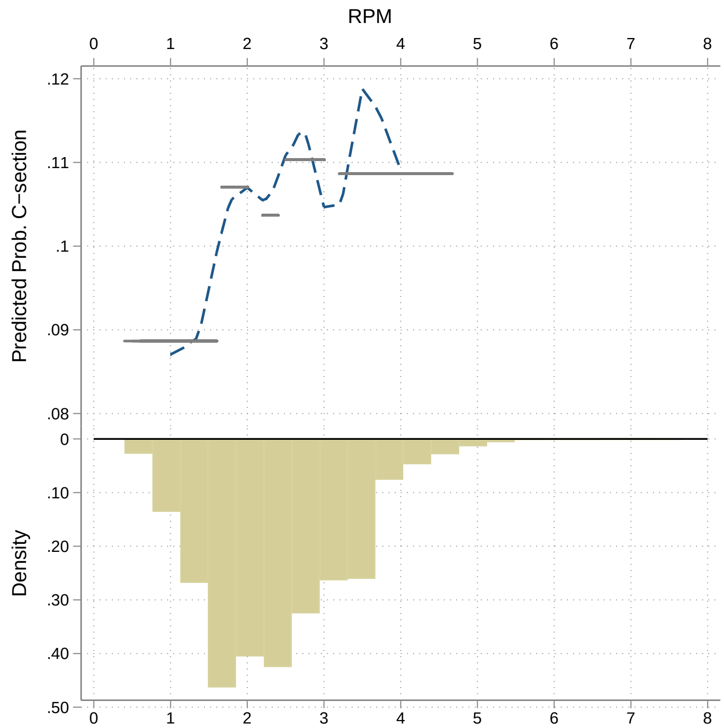
In light of this fact, I test both for a linear and non-linear relationship in the regressions below. For the latter, I divide the sample in two groups depending on whether they were

[25]This variable is constructed only with married and single women. For the sake of clarity, all women outside these two categories (divorced, separated and widows) are not considered in this part of the analysis.

[26]In fact, based on that work, the World Health Organization (WHO) guidelines recommend a companion of the woman's choice during labor and childbirth to improve health outcomes (WHO, 2018).

[27]This is the same strategy used by Evans and Kim (2006) in testing for non-linearities in the relationship between hospital staff and patient outcomes.

Figure 5.1: Density and effect of staffing on probability of C-section



Notes: In the upper panel, the solid line plots the fitted values from a regression of the probability of giving birth by C-section on a set of four dummy variables (for each quintile from second to fifth) and a constant term. The dashed line shows the (connected) predicted values from a local linear regression using a triangular kernel and a bandwidth of 0.05 RPM, shown over the subset of observations with 1 (5% percentile) to 4 (95% percentile) RPM on the x-axis. Observations with extreme values (above 99% of the distribution) are omitted for presentation purposes. The lower panel shows the density distribution of the RPM.

admitted with an RPM below (Low RPM) or above (High RPM) the 20^{th} percentile -an RPM equal to 1.6- and use this dummy variable as treatment. The key assumption is that whether a patient observes a low or high workload is uncorrelated with unobserved patient characteristics. While this is not directly testable, I provide suggestive evidence in Table 4.1 by showing that observable characteristics are balanced across the two groups. This empathizes the strength of the natural experiment used here. On the other hand, we can observe that the probability of C-section differs by workload level even in the raw means. The C-section rate for patients admitted during low RPM is 8.9%. It is almost two percentage points higher at 10.8% when admitted with high RPM.

Table 5.1 adds some precision to these findings, showing the results of estimating various specifications of equation (2). Panel (A) shows results including RPM linearly, while Panel (B) shows results using a dummy variable separating the sample in low and high RPM to test for non-linearities. Column includes only fixed effects for year, month and day-of-the-week of admission. Column two adds the mother and pregnancy controls mentioned in Section 4.4. From column three onward, all specifications use clustered standard errors at the date of admission level. Finally, columns four to six alternates different fixed effects for shift of admission, hour of admission, or a combination of shift times day-of-the-week of admission respectively.

Table 5.1: Effect of workload on the probability of C-section

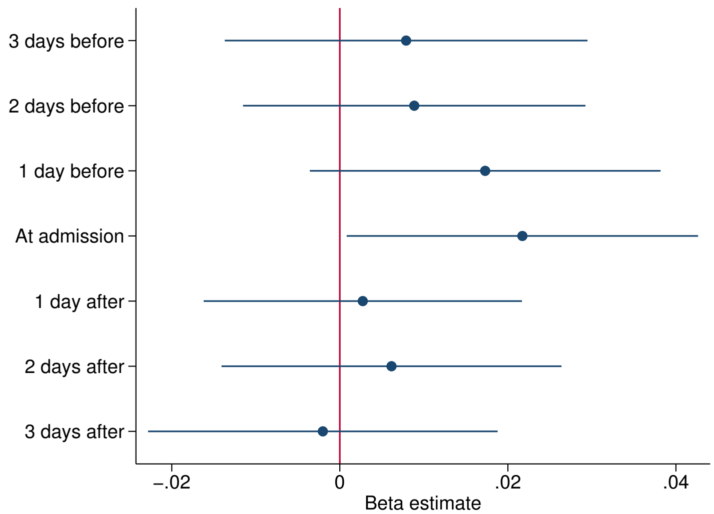
	(1)	(2)	(3)	(4)	(5)	(6)
Panel (A)						
RPM	0.007	0.007*	0.007	0.008	0.007	0.008
	(0.005)	(0.004)	(0.005)	(0.005)	(0.005)	(0.005)
Panel (B)						
High RPM	0.020**	0.021**	0.021**	0.020**	0.021**	0.022**
	(0.009)	(0.009)	(0.009)	(0.010)	(0.010)	(0.011)
Observations	6142	6142	6142	6142	6142	6142
Controls		Yes	Yes	Yes	Yes	Yes
Fixed Effects				Shift	Hour	ShiftxDoW
Cluster s.e.			Date	Date	Date	Date

Notes: All models contain fixed effects for year, month and day of the week of admission. Starting column (2), all models add mother and pregnancy controls mentioned in Section 4.4. High RPM is a dummy variable equal to one if the patient is admitted when the RPM is above the 20^{th} percentile. Standard errors are in parentheses. $***p < 0.01, **p < 0.05, *p < 0.1$

Results for the RPM added as a linear variable are not statistically significant. However, there is evidence of a non-linear effect of workload on delivery method. Patients that observe a high RPM at admission have a probability of C-section that is two percentage points than patients admitted at a low RPM. This implies an 19% increase in unscheduled C-sections with respect to the mean (10.4%). The size of the effect is comparable with previous studies looking at all C-sections and changes in monetary compensation. Allin et al. (2015) find that doubling the compensation for a C-section relative to a vaginal delivery increases the likelihood that a physician opts for the former by just more than five percentage points, all else equal. Similarly, Gruber et al. (1999) suggests that cesarean delivery rates would rise by 3.9% in response to each $100 increase in the compensation received for a C-section, all else equal.

The stability of the coefficient across columns (models) speaks to the robustness of the estimates and the exogeneity of my treatment measure. Figure 5.2 provides further evidence on this. It shows estimated coefficients using as treatment a dummy variable constructed from the RPM at different points in times expanding from three days before to three days after a patient's admission. As expected, only treatment at time of admission is statistically significant.

Figure 5.2: The effect of treatment at different points in time



Notes: The figure represents the coefficients and 95% CI from separate regressions of the probability of C-section on the treatment measured at different points in times, controlling for mother and pregnancy controls and time fixed effects as mentioned in Section 4.4.

5.1.1 Other possible channels?

So far the evidence suggests that higher workload leads to an increased likelihood of delivering by C-section. There are, however, at least two channels that can explain this relationship, other than a causal effect of workload on C-section. First, patients who are admitted in low and high workload levels are different. However, all tests performed before suggest that patients characteristics are orthogonal to the workload level at admission. As mentioned before, this is also supported by other studies.

Another possible explanation is that those type of patients who get these 'extra' C-sections actually have a preference for this delivery method. Grytten et al. (2013) find that immigrant-mothers' mode of delivery in Norway is affected by the rate of C-section in their home country -a proxy for preferences-, with a stronger effect for scheduled C-sections. However, because here I focus exclusively on unscheduled C-sections, my estimates are obtained from a sample of patients who have expressed a revealed preference for vaginal delivery by attempting labor. Given these conditions, the effect is more likely to be the result of decisions taken in the delivery room regarding when to stop labor and change treatment rather than from maternal preferences for C-sections. Nevertheless, because the data comes from a public hospital, patients may be denied an elective C-section -even when preferred- if there is no medical reason for it. Hence it is not possible to totally rule out that some demographic groups may be more inclined towards having a C-section and physicians internalize this when deciding which patient is sent to surgery.

5.2 Additional Treatment Margins

The evidence above suggests that workload shifts delivery method from vaginal birth to C-section. However, workload can affect other treatment decisions in childbirth. Two such decisions are performing an operative vaginal birth and/or an episiotomy.[28] A higher likelihood in these procedures has been linked to scarce or absent midwifery care and the presence of obstetricians or physicians instead (Hatem et al., 2008). If a lack of midwife care is negatively affecting patients' health, we would expect both these treatment decisions to go up with workload. Finally, a third margin is the use of anesthesia. The use of analgesics can be considered a more discretionary decision which is intensive in midwives' and anesthetist's time. Under time pressure, physicians may decide to reduce the use of this input.

Table 5.2 presents estimates of equation (2) using indicators for operative birth, episiotomy, any analgesic (including epidural), and whether there is no information regarding analgesic provision as dependent variables. This last one is included because about half the observations have missing data on analgesic. The absence of any statistically significant effect on having an operative birth and an episiotomy puts into question whether the raise in C-section is due to the worsening of patients health at high workload levels. Regarding the provision of analgesics, the coefficient is not statistically significant. There is, however, a 3.3 p.p. raise in the likelihood of having missing data for analgesics. This may be a consequence of an understaffed ward which reduces time invested in filling forms.

[28]Operative vaginal delivery refers to a delivery in which the physician uses forceps or a vacuum device to assist the mother in transitioning the fetus to extra-uterine life. An episiotomy is a surgical cut performed at the opening of the vagina during childbirth to help a difficult delivery.

Table 5.2: Ancillary procedures

	Operative birth		Episiotomy		Any analgesic		Missing analgesic	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
High RPM	-0.002	-0.002	0.014	0.012	0.001	0.015	0.026*	0.033*
	(0.009)	(0.010)	(0.012)	(0.013)	(0.018)	(0.021)	(0.016)	(0.017)
Observations	6142	6142	6141	6141	3086	3086	6142	6142
Mean dep.	0.088	0.088	0.186	0.186	0.269	0.269	0.498	0.498
DoWxShift FE		Yes		Yes		Yes		Yes

Notes: All models contain the mother and pregnancy controls and time fixed effects mentioned in Section 4.4. Standard errors, clustered by date of admission, are in parentheses. $***p < 0.01, **p < 0.05, *p < 0.1$

5.3 Maternal and infant morbidity

The estimates above demonstrate that patients arriving during high workload levels receive more C-sections than patients admitted at a low RPM. However, one may be also interested in the consequences of high workload on maternal and infant health. In order to test this, I re-estimate equation (2) using indicators for maternal and infant morbidity as dependent variables.

In the economics literature the most commonly studied health outcomes for births are weight-at-birth, fetal mortality and maternal mortality. However, both maternal and fetal deaths are extremely rare events in Italy: 4 per 100,000 births and 2.7 per 1,000 births, respectively. In the case of weight-at-birth, because treatment here is defined at the moment of admission to the hospital, it is considered a pre-defined outcome (not affected by treatment).[29] Nevertheless, the restricted-use version of the birth certificates in hand contains other measures of morbidity. The analysis below include those maternal and infant conditions that occur in at least 1% of births. For mothers, I only have information post-partum hemorrhage and post-birth length of stay. A higher probability of hemorrhage can be a result of low quality of care. Similarly, a longer recovery and hospital stay can be a sign of worse health conditions after birth.

For infants, I observe whether mother and child achieved skin-to-skin contact, whether the newborn was exclusively breastfeed, whether the newborn had an APGAR score below 9, and whether the newborn was transferred to a neonatal intensive care unit (NICU).[30]

[29] In fact, weight at birth is one of the variables used to assess the balancing of the sample between treatment and control groups.

[30] The Apgar score is a method used to quickly summarize the health of newborn children. The Apgar scale is determined by evaluating the newborn baby on five simple criteria on a scale from zero to two, then summing up the five values thus obtained. The resulting Apgar score ranges from zero to 10.

A higher probability of needing NICU or a low Apgar score can be signals of low care quality. Similarly, if human resources are scarce, midwives may decide to skip some steps of the service considered important but not essential. For example, they may decide that helping the newly mother achieve skin-to-skin contact with her newborn is not as important as helping another woman in labor to deliver. The same reasoning applies for not giving exclusive breastfeeding.[31]

Table 5.3 reports estimates of the effect of workload on each of the two maternal morbidity outcomes. To try and disentangle the effect of workload on morbidity independently of delivery method, I include regressions with and without conditioning for having a C-section. I find a 2.4 percentage points (21%) rise in the probability of having a post-partum hemorrhage when workload is high. However, this effect is entirely driven by the higher likelihood of delivering by C-section, as column (2) shows. Surprisingly, I find no effect of workload on length of stay. If anything, there is a slightly statistically significant and negative two percent drop. Although the effect is very small, it can be a sign of a congested maternity ward that releases patients earlier than in normal times.

Table 5.3: Maternal health

	Post-partum hemorrhage		(log) Lenght of stay	
	(1)	(2)	(3)	(4)
High RPM	0.024**	0.004	-0.017	-0.021*
	(0.011)	(0.004)	(0.012)	(0.012)
C-section		0.945***		0.231***
		(0.008)		(0.012)
Observations	6142	6142	5938	5938
Mean dep.	0.113	0.113	4.250	4.250

Notes: All models contain mother and pregnancy controls and time fixed effects mentioned in Section 4.4 and Day-of-Week of admission times shift fixed effects. Standard errors, clustered by date of admission, are in parentheses. $***p < 0.01, **p < 0.05, *p < 0.1$

Table 5.4 displays estimates of the effect of workload on each of the four infant outcomes. The coefficients are not statistically significant for all infant health outcomes at hand. How-

[31]While it is clear why a higher probability of going to NICU or having a low APGAR score are not desirable, there are also compelling arguments regarding the importance of the remaining set of outcomes. In a systematic review, Ip et al. (2007) find that breastfeeding is associated with both decreased risk for many early-life diseases and conditions as well as with health benefits to women. At the same time, skin-to-skin contact has been shown to increase the probability and length of exclusive breastfeeding (Moore et al., 2007), as well as substantially reducing neonatal mortality among preterm babies in hospitals (Lawn et al., 2010).

ever, these results should be taken with caution given that some estimates are quite imprecise due the small sample size and the rarity of some of these conditions. For example, a two percentage points increase in the lack of skin-to-skin contact represents a non trivial eleven percent increase with respect to the mean. In addition, there may be other conditions that are affected by workload but unobserved in the data at hand.

Table 5.4: Infant health

	No skin-to-skin contact		Non-exclusive breastfeeding		Apgar score<9		Neonatal ICU	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
High RPM	0.020	0.014	-0.011	-0.017	0.002	0.001	-0.007	-0.008
	(0.014)	(0.013)	(0.019)	(0.018)	(0.007)	(0.007)	(0.008)	(0.008)
C-section		0.306***		0.190***		0.047***		0.046***
		(0.021)		(0.023)		(0.011)		(0.011)
N	5415	5415	4799	4799	6142	6142	6131	6131
Mean dep.	0.180	0.180	0.322	0.322	0.047	0.047	0.072	0.072

Notes: All models contain mother and pregnancy controls and time fixed effects mentioned in Section 4.4 and Day-of-Week of admission times shift fixed effects. Standard errors, clustered by date of admission, are in parentheses. $***p < 0.01, **p < 0.05, *p < 0.1$

5.4 Physician induced demand?

The estimates above strongly suggest that higher workload leads to more C-sections. In this section I directly test whether physician induced demand can explain this effect. Under this scenario, physicians will find it easier to induce patients with a lower bargaining power. As discussed above, I expect single patients to be more affected by workload levels because they are more likely to be alone in the delivery room.

The key assumption in this exercise is that the level of care and treatment needed by married and single mothers are equally affected by workload. One potential concern is that single mothers may have a lower health than married mothers, and this difference gets exacerbated during high workload times. Then physicians may decide to send single mothers to the operative theater because of health conditions and not due to PID. Table B.3 reports average observable characteristics for married and single mothers and their differences. As expected, married mothers tend to be older, and less likely to be first-time mothers. Although the first one is a factor that can raise the need for a C-section, the second one has the opposite effect. However, all pregnancy and infant pre-treatment health characteristics are balanced across the two groups.

Table 5.5 displays estimates of the coefficients in equation (3). As expected, single mothers admitted at high workload levels have C-section rates that are 4.5 percentage points higher than those admitted during low workload. The coefficient on workload (β_1) and the coefficient on the interaction between workload and married (β_2) are statistically significant, close in magnitude and of opposite sign. The sum of coefficients and the p-value of an F-test of joint-significance is reported at the bottom of the table. Unlike single patients, married women's delivery method appears to be unaffected by workload. It is worth noting that the coefficient on being married (β_3) is not statistically different from zero, suggesting that for low levels of workload there is no difference in the likelihood of getting a C-section between single and married patients.[32]

Table 5.5: Effect of workload by civil status

	(1) All	(2) Only healthy	(3) Only young	(4) Only first-time
High RPM	0.045**	0.044**	0.045**	0.069***
	(0.018)	(0.018)	(0.022)	(0.026)
Married	0.006	0.002	0.002	-0.003
	(0.018)	(0.018)	(0.022)	(0.026)
High RPM x Married	-0.041**	-0.041*	-0.043*	-0.035
	(0.020)	(0.021)	(0.025)	(0.031)
Observations	5463	5052	3313	2306
Mean dep.	1.000	1.000	1.000	1.000
$\beta_1 + \beta_2$	0.004	0.003	0.002	0.034
F p-value	0.762	0.803	0.876	0.133

Notes: All models contain the mother and pregnancy controls and time fixed effects mentioned in Section 4.4. The number of observations is lower than in the main analysis because I drop observations that have a civil status different from single or married. Standard errors, clustered by date of admission, are in parentheses. $***p < 0.01, **p < 0.05, *p < 0.1$

In addition, the same pattern of results emerges when I restrict the sample low-risk patients -leaving out preterm and low-weight births- (column 2), young patients -below 34 years old- (column 3) and patients who are giving birth for their first time (column 4). Although for first-time mothers the interaction coefficient is not statistically significant, the

[32] Using data from the state of New Jersey (US), Currie and MacLeod (2017) observe that, conditional on C-section risk, single women are more likely to have C-sections, as are African-American and Hispanic women, less educated women, older mothers, and mothers of first born children. They do not comment on what might be behind this gap in probabilities by demographic groups, and do not separate low and high workload levels.

size of the coefficient is very close to the estimates for the other samples. Of course I cannot totally rule out that married and single patients' health are not differently affected by workload in ways beyond the observed characteristics.

6 Discussion and conclusion

This paper presents a novel approach to understand whether variations in workload affect the quality of care. My identification strategy relies on exploiting plausibly exogenous variation in the ratio of patients-to-midwives (RPM) among unscheduled patients who attempt a vaginal delivery. I find that patients admitted during high workload have a higher likelihood of getting a C-section. I fail to find an effect on other measures of treatment intensity.

This change in delivery method can be explained by a worsening of patients health condition due to lower midwife care, or by physician induced demand. I provide suggestive evidence of the present of the latter. I find that, while single and married women have the same probability of C-section when workload is low, the likelihood increases with workload for single women only. I interpret this within an agency discrimination model, where single women are more likely to be alone in the delivery room and are easier to induce.

In conclusion, I find that patients who observe a ratio of patients-to-midwives above the 20th percentile are 19 percent more likely to give birth by C-section. The effect is smaller than the effects of medical risk factors in magnitude. In comparison, in my sample of unscheduled births, the estimated C-section rate is 42 percent higher for mothers who are above 30 years old as compared to younger mothers. For newborns with a low weight-at-birth the C-section rate rises by 104 percent compared to an infant with normal weight.

My estimates imply that approximately 15 percent of unscheduled C-sections are a consequence of low midwifery staffing. In other words, if all patients were admitted with low workload levels the unscheduled C-sections rate would drop from 8.7 to 7.4 percentage points. Eliminating low-staffing instances in maternity wards would have a very significant effect on the already high levels of C-sections seen in developed countries (Italy included). Considering only the difference in costs between a vaginal and C-section delivery, these "extra C-sections" cost about €43,397 per year for the hospital under analysis.[33] Although this is not enough to hire the necessary number of midwives to assure an RPM below the 20th percentile, other costs beyond the hospital's financial burden should be considered (e.g. patients satisfaction, short and long-term effects of C-sections on mothers and infant's health). An alternative pol-

[33]Back of the envelope calculations suggest that there are about 212 "extra" C-sections in the 4 years sample due to workload. According to the prices on acute interventions published by the Italian Ministry of Health, a vaginal delivery without complication is rated at €1,272, while a C-section costs €2,092. Hence the difference (€820times the number of extra C-sections (212) divided by the number of years (4) gives €43,397.

icy is to concentrate maternity wards in fewer but bigger units and benefit from economies of scale. The larger the population a hospital serves, the lower the coefficient of variation of demand, and hence the higher the occupancy rate (Long and Feldstein, 1967).[34]

It is important to remember that this study has been carried out using data from a public hospital in a midwifery-led maternity care setting where health workers have no economic incentives that could influence treatment. Caution must be used in extrapolating these findings to other environments where maternity care is organized differently. Furthermore, although not directly tested here, it is possible that some patients, most likely those with weaker health before admission, are better off with an emergency C-section than going through a vaginal birth with low midwives' help. This remains an open question for future research.

[34]For the hospital in case this may not really be a suitable alternative since it is already a large maternity ward and the only on its city.

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A The working sample and scheduled patients

The working sample used in the main paper is restricted to only those unscheduled patients who attempt to have a vaginal delivery after going through labor, and leaves out scheduled patients. Scheduled patients can be further divided in two groups: (i) elective C-sections, and (ii) pharmacologically-induced patients. This appendix shows evidence of how the latter group's transition through the maternity ward resembles more that of elective C-section rather than the one of unscheduled patients, and hence should not be included in the working sample.

One important caveat of the data is that one cannot disentangle scheduled from unscheduled patients among those who were pharmacologically induced. However, anecdotal evidence from the ward's staff suggest that most of them are scheduled (e.g. overdue pregnancy). Furthermore, a descriptive analysis of the data seems to corroborate that. Figures A.1 and A.2 present the distribution of patients across hours and days as performed in section 1.3.1 of the main paper except that now scheduled patients are further divided between elective C-sections and induced. Starting from Figure A.1, it shows that there is a pick in admissions for both elective C-sections and induced patients during the afternoon shift, and then again a pick in time of birth (although the pick is later in the day for induced patients relative to the elective C-sections). Nevertheless, the picks are less pronounced for induced patients, suggesting that some of them may be arriving at random hours of the day like unscheduled patients do.

Even though the distribution by hours of induced patients seem to follow that of elective C-sections, their distribution by day of the week instead is closer to that of unscheduled patients. Even though admissions are slightly lower during weekends, births are evenly distributed across all days of the week. This is probably due to the fact that, as long as everything goes well, these patients are taken care of by midwives (not physicians).

The evidence provided in this appendix supports the idea of excluding both elective C-sections and pharmacologically induced patients from the working sample, but to include the latter group in the treatment variable given that they are primordially seen by midwives.

Figure A.1: Distribution of admissions and births by hour.

(a) By Time of Admission (b) By Time of Birth

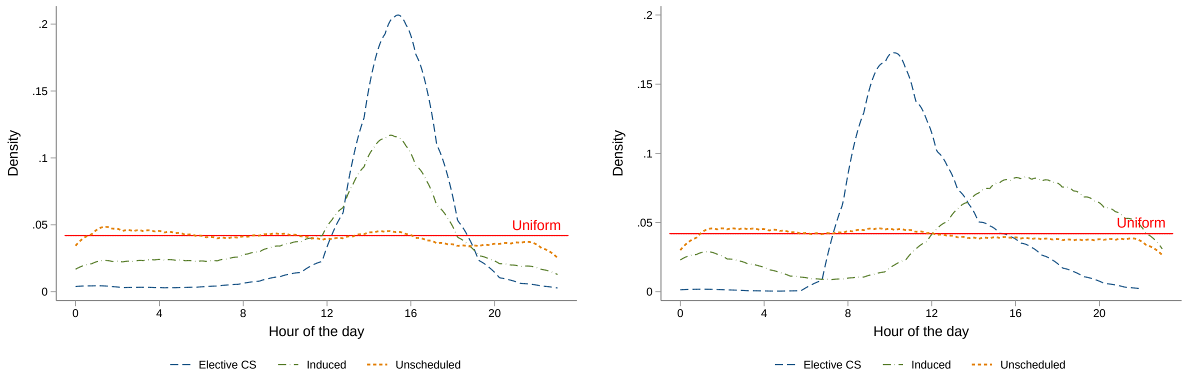
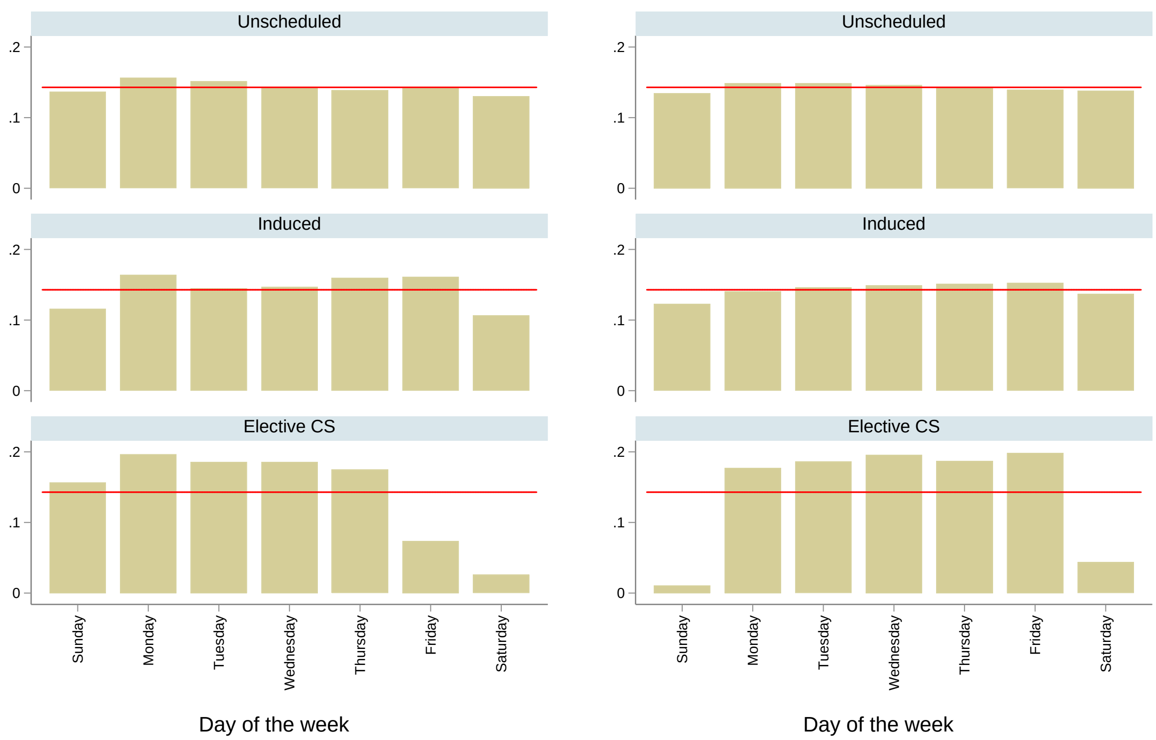


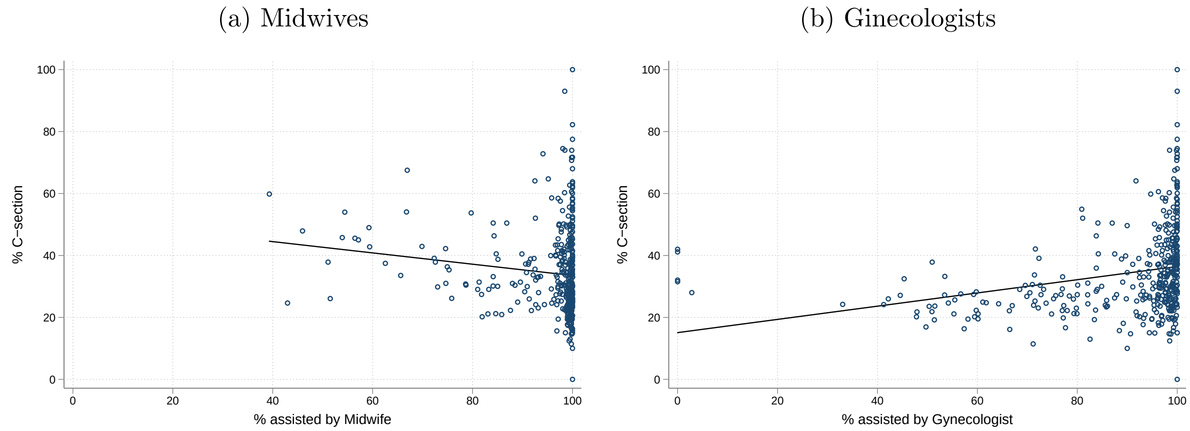
Figure A.2: Frequency of admissions and births by day.

(a) By Day of Admission (b) By Day of Birth



B Other Graphs and Tables

Figure B.1: Correlation between C-section rates and the presence of different health-workers



Notes: Data from the Italian General Directorate of Health Prevention (Ministry of Health) based on birth certificates from 2017. The sample includes 394 maternity wards in Italy out of 433 (39 units have no information on the staff present at birth). Each dot corresponds to a hospital. The solid line in each panel plots the fitted values from a regression of the C-section rate on the percent of births assisted by each health-worker.

Table B.1: The correlation between rate of C-section and the presence of different types of health-workers

	(1) Midwives	(2) Gynecologists
% births assisted by...	-0.159***	0.210***
	(0.002)	(0.001)
Mean dep.	33.437	33.437

Notes: The dependent variable is the rate of C-sections by hospital ($\times$100). The sample includes all hospitals with a maternity ward in Italy in 2017. Standard errors are in parentheses. $***p < 0.01, **p < 0.05, *p < 0.1$

Table B.2: Robustness: LPM vs Probit

	LPM		Probit	
	(1)	(2)	(3)	(4)
High RPM	0.020**	0.021**	0.019*	0.020*
	(0.009)	(0.011)	(0.010)	(0.011)
Observations	6142	6142	6142	6142
DoWxShift FE		Yes		Yes

Notes: Columns 1 and 2 use a linear regression (Linear Probability Model), while columns 3 and 4 use a Probit model. Reported coefficients are average marginal effects. All models contain the mother and pregnancy controls and time fixed effects mentioned in Section 4.4. High RPM is a dummy for patients who observe an RPM above the 20^{th} percentile. Standard errors, clustered by date of admission, are in parentheses. $***p < 0.01, **p < 0.05, *p < 0.1$

Table B.3: Balance table of married and single patients

	Married		Single		
	Mean	SD	Mean	SD	Diff.
Mother characteristics					
% age>34	40.8	49.2	36.8	48.2	-4.08**
% middle school	78.2	41.3	77.0	42.1	-1.21
% first-time mothers	37.1	48.3	51.2	50.0	14.06***
Pregnancy characteristics					
% preterm (<37 wofg)	5.7	23.2	6.3	24.3	0.57
% with at-least 1 ER visit	12.5	33.1	13.3	34.0	0.83
Infant characteristics					
% male	52.1	50.0	51.3	50.0	-0.80
(mean) weight in grams	3,276.9	526.5	3,249.1	534.1	-27.80
% low birthweight (< 2,500gr)	4.9	21.6	5.2	22.3	0.32
% high birthweight (> 4,000gr)	5.2	22.2	4.7	21.1	-0.49
Outcomes					
% vaginal births	90.8	28.9	88.0	32.5	-2.83**
% unscheduled C-sections	9.2	28.9	12.0	32.5	2.83**
% operative births	8.2	27.5	9.8	29.8	1.59
% transfered to neonatal ICU	6.2	24.1	8.3	27.6	2.12**
% lack of skin-to-skin contact	16.8	37.4	19.1	39.4	2.36*
% non-exclusive breastfeeding	30.3	46.0	34.9	47.7	4.60**
% Apgar score<9	4.1	19.9	5.5	22.8	1.35*
Observations	3477		1986		5463

Notes: Table contains variables used in the main empirical analysis for the main estimation sample for the period 2011-2014. The last column reports differences in married and single means and whether they are statistically significantly different from zero and standard levels.

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